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VOL. 6. No. 61. JANUARY. 1952. Price 1/6d. Annual Subscription: Fifteen Shillings

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No. 61 JANUARY, 1952 Vol. 6

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FIVE YEARS OLD

With the December 1951 issue, the *Institute of Petroleum Review* completed the fifth year of its existence and with the commencement of the sixth year it is perhaps opportune to consider how far the ideas which led to the launching of this second monthly publication of the Institute of Petroleum have been, in fact, realized. The inception of the *IP Review* was partly a consequence of the enlargement of the scope of the Institute of Petroleum, as compared with the Institution of Petroleum Technologists, and increased interest in aspects of petroleum other than the purely technical and technological. It was due also to the desire to provide a house organ for the Institute and particularly one which would interest and appeal to the Branch members also.

It was considered that this second journal should bring to the members news of the Institute, its Council and committees, of the industry, and of people in it; and it should contain articles on technical and other aspects of the industry, written so that they would be of interest to members in all branches; and that there should be articles of educational value to the student.

These aims have not been so easy to achieve. For example, providing technical articles which would appeal to a wide circle of members has proved quite difficult, as writing such articles requires much more attention to phrasing and composition in order to achieve the necessary clarity and arouse and retain the interest of the general reader,

than is normally given to a paper on a research subject. The selection of authors and subjects has required much thought by the committee responsible. The publication of articles of interest and value to the student has been regarded as of particular importance and two special series of articles relating to tests and their significance have appeared. It is hoped that it may be possible to republish these in a convenient form. Considerable attention has been given to the activities in the Branches, and in addition to the technical and semi-technical articles specially contributed, a number of addresses given to Branches have been published in the *IP Review*. An informative cross-section of the industry has also been presented by means of first-hand accounts of important functions and notes of personalities and their activities.

The policy laid down for the *IP Review* has been reconsidered on numerous occasions without, however, leading to very substantial alterations to the original scheme. Such reconsideration has been in the light of criticisms and comments which were frequently received in the earlier days of publication. Such constructive criticism and comment has always been welcome and it is from these that the views of the readers can be judged.

Another matter which has and is, in fact, currently receiving attention is that of increasing the size and format of the *IP Review*. Unfortunately shortage of paper and the rising cost of printing may prevent such enlargement taking place as soon as might be wished.

It is gratifying to feel that the *IP Review* has now established itself among world petroleum periodicals and as such has been so widely accepted. That this is so has been due to the efforts and co-operation of many people—members of Institute committees, contributors of articles, referees, and all who have helped by supplying us with notes and information, or with helpful criticism. We are confident that the *IP Review* will continue to extend in interest and value, not only to members of the Institute but also to the ever-widening circle of readers outside our own membership.

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NEW YEAR HONOURS

The following are among those upon whom His Majesty the King has conferred honours on the occasion of the New Year:

J. P. Berkin, M.Inst.Pet., manager, Shell Petroleum Co. Ltd. (C.B.E.).

A. E. C. Drake, lately general manager in Persia, Anglo-Iranian Oil Co. Ltd. (C.B.E.).

G. O. Higgins, A.M.Inst.Pet., lately managing director, Sarawak Oilfields Ltd. (C.B.E.).

C. E. Evans, F.Inst.Pet., lately works manager, Abadan, Anglo-Iranian Oil Co. Ltd. (O.B.E.).

J. W. Jackson, F.Inst.P., lately fields manager, Southern District, Anglo-Iranian Oil Co. Ltd. (O.B.E.).

Captain J. P. Thomson, lately marine superintendent, Eagle Oil and Shipping Co. Ltd. (O.B.E.).

R. K. Blackwood, lately engineer in Persia, Anglo-Iranian Oil Co. Ltd. (M.B.E.).

MODERN TECHNIQUES IN PETROLEUM TESTING

VI. DEVELOPMENT OF ENGINE TESTS FOR LUBRICATING OILS

By J. G. WITHERS*

Introduction

The purpose of any test on a given product is to assess in a reliable and simple manner the behaviour of the product when called upon to perform the function for which it is intended. Thus in the examination of engine lubricating oils the aim is to devise tests which accurately forecast the performance of oils in production engines under service conditions. However, service conditions vary widely in severity, and it is usual to base laboratory engine tests on the characteristics of difficult engines under extremes of operating conditions on the assumption that such cases represent the severest duty, and that, if these are satisfied, all others will be free from complaint.

Before a laboratory engine test specification can be laid down it is necessary to obtain the basic data from the field. Unfortunately there has been a tendency in the past to base tests on what is, at the very best, scanty service information, largely on account of the difficulties and expense of providing an adequate background of knowledge.

The following are the main performance characteristics of a lubricating oil which must be examined to estimate its probable behaviour when used in service.

(a) *Piston ring sticking, cylinder and piston lacquering, and ring groove deposits*

These are, in general, aggravated by heavy duty and high cylinder and piston temperatures. The highest temperatures are generally met in two-stroke cycle engines and supercharged engines, where increased output is obtained from a given cylinder size. The fuel used has also an effect on piston cleanliness if partially burnt products can contaminate the lubricating oil; sulphur in the fuel is also stated to increase deposit troubles. Heavy duty oils containing additives with detergent properties are designed to minimize the deposition of lacquer, carbon, and sludge from both the fuel and the lubricating oil.

(b) *Cylinder and piston ring wear*

Excessive wear can be caused by abrasion from solid particles introduced into the engine as foreign matter in the air, fuel, or lubricating oil and by abrasion from hard carbon deposits. Another cause of wear is corrosion from the condensation on the cylinder's walls of acids in the combustion products. Normally wear is lessened by high operating temperatures but increased by high piston speed, heavy duty, and supercharging. The lubricating oil can reduce wear by virtue of high film strength by providing a corrosion-resistant film, and by maintaining satisfactory piston ring conditions because of any detergent properties it may possess.

(c) *Sludge deposition*

Deposits of sludge in oilways or other parts of the engine system are usually aggravated by cool running conditions, particularly if temperatures are low enough to permit water condensation. A good lubricating oil, while minimizing the deposition of carbonaceous material on the piston and cylinder, should, in addition, keep it in suspension in the oil and not allow its accumulation in other parts of the engine.

*Anglo-Iranian Oil Co.

(d) *Corrosion of bearings*

Some bearing alloys, notably copper-lead, nickel-cadmium and silver-cadmium are subject to corrosion by acid products formed in the lubricating oil. The rate of corrosion is accelerated by high operating oil temperature, which causes oxidation and the formation of acids. Suitable additives can be incorporated in the oil which either protect the metal surfaces from attack or inhibit the breakdown of the oil.

(e) *Combustion chamber deposits*

Ash and carbonaceous deposits from the lubricating oil, or any additive it may contain, should not build up to any extent in the combustion chamber or in the inlet or exhaust ports. In addition to the obvious ill-effects of such deposits, e.g., exhaust and inlet valve failure, spark plug troubles and loss of volumetric efficiency, they may build up on the cylinder beyond the limit of top ring travel and so increase scratching of the top land of the piston, to an extent which may cause ring sticking due to the displaced metal from the top land restricting the movement of the top piston ring.

(f) *Deterioration of the oil*

The effective viscosity of an oil in use may change due to oxidation, dilution with fuel, and the accumulation of carbonaceous matter in suspension. The amounts of insoluble material in suspension in used oils must be interpreted with caution since a detergent oil, which gives a clean piston, will probably, in the used condition, contain more suspended carbonaceous material. Less importance is now attached to the analysis of used oils and increasing emphasis placed on the condition of the engine; in other words, provided an oil will give satisfactory performance in the engine in all respects and does not require changing too frequently, then its appearance and analysis after use are of little consequence.

(g) *Filterability*

Oils should be capable of being filtered in the new and used condition in all types of filter in commercial use without causing rapid choking; and the active additives, if any, should not be removed below a safe minimum by the process of filtration.

(h) *Foaming tendency*

The formation of foam may be troublesome especially in aircraft engines at high altitude or other conditions where excessive aeration can occur. Heavy foaming can lead to loss of oil and may result in bearing failures. Additives are available to reduce foaming, where this is an inherent characteristic of a lubricating oil or additive.

(i) *Lubricating value of the oil*

Provided that the viscosity of the oil is high enough at the working temperature, troubles are seldom experienced with engine bearing lubrication. Film strength may play a part, but there is little experimental evidence of its significance in actual engines. Friction losses under running conditions are almost entirely a function of the viscosity at the prevailing temperature. Under cold starting conditions the viscosity at the starting temperature is the most important factor.

(j) *Oil consumption*

The rate of oil consumption is normally a function of engine condition and oil viscosity. However, oils which have a strong detergent action and maintain efficient ring action will, in the long run, give lower rates of consumption. Oils giving low rates of wear require a longer running-in time for new engines and will give high initial rates of consumption, but once running-in is completed a low rate of consumption will be maintained for a longer time.

It is desirable that laboratory tests intended for predicting service behaviour should be as short as possible on the

grounds of economy, but they should not be accelerated to such an extent that they cease to indicate the relative behaviour of oils under service conditions.

Considerable experience in the engine testing of lubricating oils has been accumulated during the last twenty years but it is only comparatively recently that serious efforts have been made to standardize engine tests. It will, of course, be obvious that one test method cannot possibly test an oil for all aspects of performance, but nevertheless standardization of test methods is highly desirable and the number of individual methods should be reduced to the minimum consistent with satisfactory evaluation of oil performance.

Development and Standardization of Tests for Motor and Diesel Lubricating Oils

The first engine test unit to be widely used was the single cylinder Caterpillar diesel of $5\frac{3}{4}$-inch bore and 8-inch stroke, which was specially designed for the laboratory testing of lubricating oil for ring sticking, piston deposits, and cylinder wear. It first came into use about 1937 because the Caterpillar Tractor Co. would only give approval to branded motor oils which had passed their 480 hr engine test. The piston and cylinder assembly is essentially that used in the standard production engine; and the general construction of the unit is very rugged so as to minimize the risk of mechanical failures which would interfere with the test routine. Moreover, the unit is so designed that it can be dismantled in twenty minutes for inspection of the cylinder liner, piston, and rings. As a test engine it has proved very satisfactory.

The General Motors Corporation have also adopted the policy of approving heavy-duty oils on the basis of tests carried out in engines of their own design and manufacture. They introduced a thirty-six hour accelerated test, using the six-cylinder Chevrolet engine, for determining resistance to oxidation, bearing corrosion, and piston lacquering in heavy-duty gasoline engines.

These American tests were originated by the engine manufacturers ; but they were readily accepted by the oil companies as a means of developing acceptable heavy-duty oils.

In 1941, the U.S. Army Motorized Ground Forces standardized the use of heavy-duty oils, and, under the Allied pooling arrangements, this policy was extended in 1942 to include British military equipment. Since that time Army-Navy heavy-duty oils, to 2-104B specification, have been subject to qualification tests laid down by the Co-ordinating Research Council in New York. Originally there were five tests but only two have survived, and these are based on the original tests developed by Caterpillar and General Motors, using the experimental single-cylinder diesel engine (CRC L-1 procedure) and the Chevrolet engine (CRC L-4 procedure) respectively. Both these procedures are at present widely used both in the United Kingdom and in the United States.

The more important running conditions for the Caterpillar engine when using the CRC L-1 480 hr procedure are as follows: speed 1000 r.p.m.; brake mean effective pressure 80 p.s.i.; lubricating oil temperature 65°C; and jacket temperature 80°C. The top piston ring groove temperature which is the main factor controlling ring sticking and groove carbon is then 160/185°C. The conditions are easy from the point of view of crankcase conditions but somewhat severe with regard to the piston. Oils are judged by the condition of various parts of the piston, including ring grooves, lands, and skirt; and an elaborate assessment procedure has been developed which makes it possible to give numerical ratings to the discolorations and deposits.

Recently the U.S. Army 2-104B specification has been superseded by the MIL-0-2104 specification which stipulates that the fuel for the L-1 test shall have a sulphur content of not less than 0.35 per cent instead of not more than 0.4 per cent.

The L-4 test in the Chevrolet engine is run for 36 hr under the following conditions: Speed 3150 r.p.m.; brake mean effective pressure 35 p.s.i.; lubricating oil temperature 138°C and jacket temperature 93°C. These conditions are particularly severe with regard to the conditions in the crankcase and promote rapid breakdown of the oil to form acids which attack the copper-lead bearings used in the test. Piston condition is observed but there is little discrimination shown between oils of premium and heavy-duty quality, only poor quality oils giving dirty pistons.

The Chevrolet engine is also used under other operating conditions than those specified for the L-4 procedure, in particular, with lower cylinder jacket and lubricating oil temperatures to accentuate the effects of deposits formed from the fuel. One of such tests is the test designated CRC—F.L-2. The running conditons are: speed 2,500 r.p.m.; brake mean effective pressure about 65 p.s.i.; lubricating oil temperature 74°C and jacket outlet temperature 35°C.

Further tests have also been developed on the single-cylinder Caterpillar engine for testing improved heavy-duty oils which, until the introduction of the MIL-0-2104 specification, were known as Supplemental List 1 and 2 oils; the specifications for these improved H.D. oils being supplemental to the original 2-104B specification. However, even though the grades have been withdrawn from the U.S. Army lists certain engine builders still recommend their use when engines are operated under special conditions. Supplemental List 1 oils are tested by the Caterpillar L-1 test with the fuel sulphur content increased to 1.0 per cent because it is claimed that in this engine, the use of high sulphur fuels increases engine fouling (Caterpillar 1-E procedure). Supplemental List 2 oils, in addition, are operated on the same fuel under supercharged conditions which further aggravate fouling and ring sticking. The supercharged test is known as the Caterpillar 1-D procedure, and is run for 480 hr at 1200 r.p.m., 135 p.s.i. brake mean effective pressure, 80°C temperature of the oil to the bearings, and 93°C coolant outlet temperature. This test is thus much more severe than the L-1 in all respects.

While considerable experimental work has been done in Great Britain on lubricating oil behaviour in engines, until comparatively recently, little has been done towards the development of standard test procedures apart from tests required for approval purposes by some aero engine manufacturers. About three years ago the Engine Tests of Lubricants Panel of the Institute of Petroleum, at the request of the Ministry of Supply and the Admiralty, decided to sponsor the development of two special engines for carrying out lubricating oil tests. The first is a small spark-ignition engine, known as the Sunbury engine and designed by the Anglo-Iranian Oil Company. The design incorporates means for measuring piston ring groove and crankpin temperatures, which are critical factors controlling ring sticking and bearing corrosion respectively. This engine was originally intended for the testing of aviation oils for ring gumming, and for bearing corrosion tests; with a suitable fuel, however, it also shows promise of correlating with the Caterpillar L-1 procedure for the testing of heavy-duty oils for piston carbonization and lacquering. The second engine, designed by Ricardo in collaboration with the Shell Petroleum Company, consists of a universal crankcase which will take several types of diesel engine cylinder and combustion chamber. Its purpose

is for the testing of heavy-duty oils under normal and supercharged conditions with particular reference to correlation with the Caterpillar L-1, 1-D, and I-E procedures. Active development of test procedures is taking place in both engines.

Aviation Engine Oil Testing

The problem of devising engine tests for lubricating oils to be used in reciprocating aircraft engines is not greatly different from the corresponding problem of motor oils. Correlation of a laboratory engine test with service behaviour is equally important in this field, and before a test is introduced into specifications, correlation with flight tests on a wide range of oils should be established. Flight tests, although very costly, are somewhat easier to carry out than road tests as in the former case the range of operating conditions is less and, generally speaking, greater control can be exercised. Further, since aircraft engines are more fully instrumented, the operating conditions can be readily determined, and bench tests in full scale engines run under simulated flying conditions have, therefore, a considerable value, and may in some cases be acceptable in place of flight tests.

Aircraft engines operate at a high specific output; and, particularly in air-cooled types, the cylinder temperatures may reach very high values. Such conditions promote piston ring sticking, piston fouling, and rocker box carbonization, and thus detergency characteristics in the lubricating oil are of great importance. However, detergent additives for use in aero engine oils have to be carefully selected to avoid excessive deposits of additive ash in the combustion chamber. The build-up of such deposits may cause preignition, and spark plug and exhaust valve trouble. Experience has shown that liquid cooled engines can be more prone to these troubles than air-cooled units. The solution to these difficulties would be an ashless detergent additive and much development work is now taking place in this direction.

The deposition of sludge, particularly in oil ways, is a feature of lubricating oil behaviour that should also be examined. The sludge will tend to accumulate in oil channels subjected to centrifugal force, such as the crankpin and the supercharger drive.

In some engines, on account of the high duty, crankpin bearings are made of nickel-cadmium or silver-cadmium alloy. These alloys are subject to corrosion by acid products formed in the lubricating oil particularly under conditions of high oil temperature. It should be mentioned that a clean copper surface has a catalytic effect on the break-down of the lubricating oil, and thus, in the carrying out of oil tests in which bearing corrosion is to be examined, any copper pipes in contact with the oil should be cleaned to give a reproducible surface condition. It is very difficult to examine and clean the insides of pipes and for laboratory tests it is preferable to use steel oil pipes, which have little catalytic effect; and, since copper is used in most main engines, to introduce copper in the form of a sheet of suitable area into the oil tank. Such a sheet can be very easily cleaned in a consistent manner before each test.

In many engines the crankcase oil is also called upon to lubricate the propeller reduction gears and under high loading conditions, scuffing of the gears may take place. The use of film-strength improving additives can mitigate this trouble, but in certain cases the corrosive properties of the oil may be increased.

Foaming of the oil, particularly under altitude conditions, may be troublesome. The cause of the foaming is aeration of the oil in the scavenge oil pump, and, in bad cases, the foam will not break in the oil tank, with the result that oil

may be lost through vents and the engine may be fed with a mixture of air and oil. Detergent additives may increase the foaming tendency of an oil.

The testing of lubricants for gas-turbine engines resolves itself in the main into the lubrication of high speed heavily loaded bearings and gearing at high temperatures. Much useful work in this field can be carried out on specially-designed rigs but these are outside the scope of this article.

While it may be necessary to type test any new oil or additive in suitably chosen full-scale engines, the cost of such tests and the quantity of oil used is far too great for experimental work in lubricating oil development or for the proving of each consignment of a previously approved oil. In Great Britain certain aircraft engine manufacturers have made available special single-cylinder units which embody the piston and cylinder assemblies of a production engine together with certain other features essential to the carrying out of lubricating oil tests. In some cases the oil test procedure has been laid down by the engine manufacturers. One such procedure is the Bristol Hercules R.G.2. The more important running conditions are: speed 2,800 r.p.m.; brake mean effective pressure 220 p.s.i.; lubricating oil inlet temperature 100°C, cylinder head control temperature 290°C. The top piston ring groove under these conditions operates at a temperature of about 290 C. The test is thus extremely severe from the point of view of ring gumming. Each test is terminated when symptoms of ring sticking occur, indicated by increased crankcase blow-by, drop in output and changes in the cylinder barrel temperature distribution. The quality of an oil is judged by the time interval before ring sticking occurs. Tests of this type show a considerable saving in cost and oil sample quantity but they are still too high for rough sorting and preliminary investigations.

No widely accepted standard laboratory engine tests have yet been developed for aviation lubricating oils. The British DED-2472 specification stipulates that evidence should be produced of the satisfactory engine performance of the oil but does not indicate a standardized procedure to be followed. The ultimate proving of an oil is, of course, use in the engines for which it is intended, but it is hoped that it will not be long before simple proven laboratory engine test procedures are available. In this respect the IP Sunbury Engine by matching piston ring groove temperatures and without supercharging has already shown success in correlating with the Hercules R.G.2. engine.

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JERSEY STANDARD CARIBBEAN COMPANIES

To meet the administrative requirements in the Caribbean area Standard Oil Company (New Jersey) is to reorganize the operations of six wholly-owned affiliates into one company with headquarters at Havana.

The name of the present Esso Standard Oil (Central America) S.A. will be changed to Esso Standard Oil S.A., and this company will acquire the business and assets of: Esso Standard Oil (Antilles) S.A.; Esso Standard Oil (Caribbean) S.A.; Esso Standard Oil Company (Cuba); Esso Standard Oil Company (Puerto Rico), and Standard Oil (Canal Zone) Company.

President of the new company will be Fred H. Billups, now Western Hemisphere marketing advisor for Jersey Standard. Henry P. Blackeby, assistant comptroller of Jersey Standard, will be chairman of the Board.

ANGLO-IRANIAN PRODUCTION

In his annual statement to the Stockholders, the Chairman of the Anglo-Iranian Oil Co. Ltd. reports that crude oil production in Iran in 1950 was 31,750,000 (26,807,000 tons in 1949). Of this the Agha Jari and Haft Kel fields contributed 15,620,000 and 9,133,000 tons respectively.

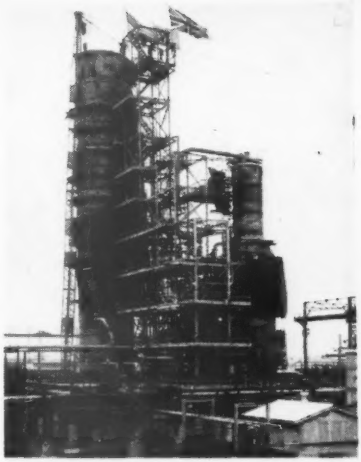
The company also obtained 7,367,000 tons from Kuwait, 1,681,000 tons from Iraq, 384,000 tons from Naft Khaneh, 380,000 tons from Qatar, and 46,000 tons from Nottinghamshire.

Refining

Abadan refinery processed 24,054,000 tons of crude during 1950. The topping plant at Kuwait processed 1,054,000 tons of crude oil for local needs and ships' bunkers. In the U.K. total throughput at Llandarcy was 2,634,000 tons and at Grangmouth 657,000 tons.

In France the L'Avera refinery had a throughput of 1,551,000 tons and at Dunkirk the figure was 336,000 tons.

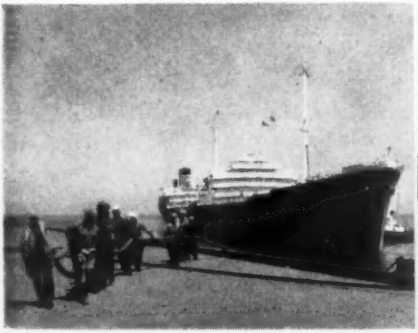
The Porta Marghera refinery in Italy processed 561,000 tons and 351,500 tons were processed at Hamburg in 1950 after reconstruction work was completed in August.

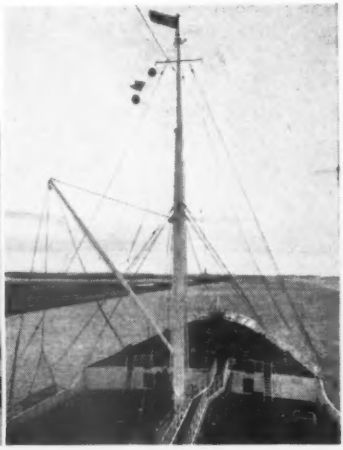


Work began in the autumn of 1950 on the new refinery on the Isle of Grain. Refining is expected to begin in 1952 at two million tons per annum and to be doubled by the end of that year. This photo shows a distillation column being "cappe ."

In Scotland, 1,454,000 tons of shale was mined and 112,000 tons of crude oil and 17,500 tons of sulphate of ammonia produced.

The 28,000-ton British Adventure, *largest of the British Tanker Co's fleet, arriving at Mina el Ahmadi, Kuwait, and homeward bound through the Suez Canal with 7,500,.00 gallons of crude.*



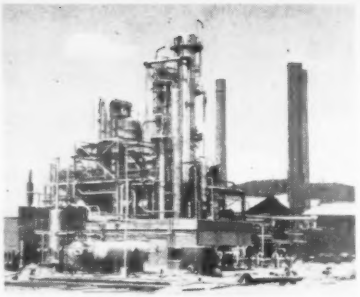


The first part of the British Petroleum Chemicals Ltd. plant at Grangemouth came into operation in May 1951. It will produce gases for chemical synthesis and motor spirit.

Summary

The operations of the Anglo-Iranian Oil Co. and associated companies during 1950 are summarized as:

	1950	1949
	Thousand tons	
Crude oil production	41,720	33,937
Refinery throughput	31,507	27,982
Sales of refined products and crude oil	38,500	30,500
Tonnage of ocean going tankers owned at end of year ...	1,717	15,300



In Belgium a refinery at Antwerp jointly owned by Anglo-Iranian and Petrofina will have a capacity of 1,800,000 tons per annum on completion. A general view of the vis-breaker unit is shown above.

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LABOUR STATISTICS FOR THE U.K. PETROLEUM REFINING INDUSTRY

The following figures are taken from the September 1951 issue the *Ministry of Labour Gazette*. The basis on which they have been determined is similar to that for previous figures, published in the *I.P. Review* (1951, **5**, 168).

Figures in bold type are the averages for all the industries covered by the tables.

	Men (21 and over)	Youths and Boys	Women (18 and over)	Girls	All Workers
No. of wage-earners covered by remuneration statistics ...	10,896	591	667	12	12,166
Average earnings in last pay-week in April 1951 ...	167/0 **160/2**	64/10 **66/11**	98/1 **87/4**	—	158/2 **136/2**
Average number of hours worked in this pay-week	48.6 **47.9**	44.6 **44.5**	46.2 **42.0**	—	48.3 **46.3**
Average hourly earnings in this pay-week (pence) ...	41.2 **40.1**	17.4 **18.0**	25.5 **25.0**	—	39.3 **35.3**
			Males	Females	
Numbers employed (July 1951)			34,100	6,600	40,700
Numbers unemployed (at August 13, 1951)			141	33	174
Labour turnover rate (5 weeks ended June 30, 1951)					
No. of engagements per 100 employed			4.2 **2.9**	1.8 **4.1**	3.9 **3.3**
No. of discharges and other losses per 100 employed			2.0 **3.1**	3.1 **4.1**	2.2 **3.4**

COUNCIL COMMENTARY

A meeting of Council was held on Wednesday November 14 with Dr E. B. Evans, vice-president, in the chair. The President was still overseas and cabled regretting his inability to be present.

Arrangements for renewing the lease of Manson House have now been agreed and the present lease is to be extended on the same terms for 10 years from October 1952 with option on either side to break the contract at the end of five years. All would like to see the Institute housed in a building of its own but present conditions do not favour this. However, the matter is to be kept continually under review by the House Committee.

Three new vice-presidents have been nominated to fill the vacancies caused by the retirement of M. A. L. Banks, J. S. Parker and E. J. Dunstan after their three years period of service. The successful candidates were H. Hyams, H. E. F. Pracy and R. B. Southall all of whom are untiring workers in Institute affairs. The Hon. Treasurer and Hon. Secretary have again been re-nominated for these offices which they have filled so effectively for a number of years.

The Election Committee have assumed responsibility for maintaining an up-to-date list of members and have recommended publication at two-yearly intervals. Council discussed this with special reference to the frequency of issue. It was considered that on account of expense annual publication was not justified but that too long an interval was undesirable since the list rapidly becomes out of date and thus of little use. The Election Committee's recommendation was accepted as a reasonable compromise.

A meeting of the Branches Committee was held at Birmingham University on November 6 and a report was submitted to Council. Application has been made to form a Persian Gulf Branch and this was approved.

Reports from Branch secretaries reveal a very healthy state of affairs in all Branches. The Northern Branch now has 190 Corporate and 9 Student members and has a good programme of papers for the current session besides a film show and the annual dinner/dance.

Fawley, with 57 Corporate and 61 Branch members has five more meetings fixed and the annual dinner in December.

South Wales has 55 Corporate, 14 Student, and 40 Branch members and recorded their largest-ever attendance at the opening meeting.

There are 141 Corporate and 53 Branch members in the Stanlow Branch and a full programme has been arranged. The financial situation of the Branch is also highly satisfactory.

London Branch with 151 Corporate and 137 Branch members is, as one would expect, the largest member of the family. The programme for 1951/2 includes a buffet dance—now already held.

In Scotland the Branch can boast 68 Corporate, 69 Branch, and 2 Student members and arrangements include four papers and two film shows.

Birmingham University Students' Section has 100 members of which 4 are Corporate and 21 Student members of the Institute. A good proportion of the papers presented last session were connected with petroleum and this position is being maintained during the present session.

There are six ex-officio positions on Council filled by Officers drawn from the various branches in Great Britain. Branches Committee considered whether one of these vacancies should be given each year to one of the overseas branches. Since it was doubtful if an overseas branch could take any advantage of this suggestion it was withdrawn, and instead a recommendation made that

the chairman of such a branch should be invited to attend a Council Meeting while in England on leave. This was agreed.

An interesting discussion took place on the best way of keeping overseas branches informed of the activities of Council. It was the unanimous opinion that such information would help to keep the distant branches in close touch with the parent body and it has therefore been decided that the overseas branch liaison officer—H. E. F. Pracy—should send them a résumé of Council deliberations at suitable intervals.

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COLOUR MEASUREMENT

By the courtesy of Tintometer Ltd., Mr G. J. Chamberlain (managing director of that firm) recently discussed and answered questions on the physical and physiological basis of colour measurement at two meetings held at this Institute. After outlining present-day theories of colour and colour mixing, the qualities needed in illuminants and the variations in sensitiveness to colour differences shown both in normal and abnormal vision, Mr Chamberlain demonstrated the use of apparatus and analytical methods in which these principles were applied, his audiences also being given the opportunity of verifying the normality of their own sight on the Ishihara chart. The Institute expresses its indebtedness to Tintometer Ltd. and in particular to Mr Chamberlain for his very useful discussions and demonstrations.

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PROPOSED NEW REFINERY IN INDIA

The Burmah Oil Company and the Shell Group, the two partners in Burmah-Shell India, have agreed to erect a refinery at Bombay at the request of the Government of India. Estimated cost is £16.5 million and annual capacity 1,500,000 tons.

PERSONAL NOTES

E. LeQ. Herbert, B.Sc., F.Inst.Pet., Member of Council, has been appointed general manager of "Shell" Refining & Marketing Co. Ltd. to succeed **J. A. Oriel,** F.Inst.Pet., Member of Council.

James Grant

James Grant, F.Inst.Pet., who for the past year has been assistant manager of the Stanlow refinery, has been appointed manager of the Shell Haven (Essex) refinery. **R. W. J. Smith,** F.Inst.Pet., whom he succeeds, has returned to a head office appointment in London.

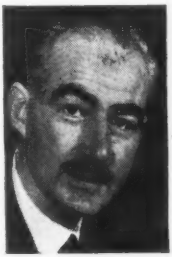
Kenneth Gordon, C.B.E., M.C., M.A., F.Inst.Pet., has been appointed deputy managing director of Head Wrightson Processes Ltd.

David A. Shepard, F.Inst.Pet., who was elected a director of Standard Oil Co. (New Jersey) from December 1, 1951, first joined the company as a research engineer in 1927. Later and until 1940 he was European representative of the Standard Oil Development Co., and subsequently became technical adviser on foreign sales for Jersey Standard with headquarters in London. After serving as Petroleum Attaché at the U.S. Embassy in London, he was appointed shareholders' representative of Jersey Standard in the U.K. and later became chairman of Esso

Petroleum Co. Ltd. He returned to New York, as executive assistant to the president of Jersey Standard in 1949.

Emile E. Soubry, director of Standard Oil Co. (New Jersey) since January 1, 1949, has been elected a vice-president of the company from December 1, 1951. He started his career as a clerk in the Shipping Department of Esso Petroleum Co. Ltd. (then Anglo-American Oil Co. Ltd.) in London in 1911, was appointed its chairman just before the late war, and joined Jersey Standard as its foreign marketing co-ordinator in 1943.

After 32 years service with Shell, **J. L. Flanagan**, M. Inst.Pet., manager of the Fuel Oil General department at Head Office in London, retired on December 31. For the past 19 years Mr Flanagan has been responsible for world wide marketing (outside U.S.A. and Canada) of fuel oil, diesel fuel, and gas oil and is well known in international shipping circles for his work on fuel oil bunker supplies. His successor is **D. B. Vale**, O.B.E., formerly deputy manager of the Fuel Oil General department, who joined Shell in 1930.



Recent Shell-Mex and B.P. appointments include that of **A. L. King** to be general staff and industrial relations manager. **F. A. Keeling**, chief accountant of the company, has joined the management as controller of accounts.

For reasons of health, **B. Th. van Hasselt** has resigned from his position of director-general, Royal Dutch Petroleum Co. and of managing director of the operating companies of the Royal Dutch/Shell Group. In view of the foregoing, **L. Schepers**, formerly a manager of N.V. de Bataafsche Petroleum Mij., and responsible for the co-ordination of exploration and production activities, has been appointed a managing director of Anglo-Saxon Petroleum Co., of Shell Petroleum Co., and N.V. de Bataafsche Petroleum Mij.

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KUWAIT OIL CONCESSION

It is announced that negotiations between His Highness the Shaikh of Kuwait and the Kuwait Oil Co. Ltd., have been concluded and agreement has been reached on all outstanding matters.

The company will submit to an income tax to be imposed by His Highness from 1 December 1951 which will bring about the equal sharing of profits by Kuwait and the company. In this way Kuwait's revenue due to the crude oil production will be comparable to the revenue from this source existing in neighbouring Arab States.

Provision has also been made for a contribution by the company to the cost of the higher education of Kuwaiti students and universities and schools outside Kuwait.

LONDON BRANCH

Buffet Dance

Following the successful experiment last year, the London Branch held its second Buffet Dance on the evening of Friday, November 16, once again at Manson House, which, as last year, had been very effectively transformed from its normal severely academic appearance, principally by the efforts of the Institute's general secretary, Mr D. A. Hough.

About 120 members, wives and friends were present and dancing got under way in good time under the tactful guidance of Mr Maliphant as M.C. A good buffet and a very adequate bar kept everyone in a sound state of preservation and able to cope with even the most active of the evolutions demanded by Eric Lambert, who again brought his excellent little band to provide the music.

A special licence enabled the bar to keep open until half past eleven and the pace was kept up until midnight, when the dance, which it was felt had now won for itself a firm place in the social arrangements of the branch, came to an end.

Branch Meeting

On the evening of November 20 the London Branch held its third meeting of the current session at Manson House to hear Mr A. B. C. Licence, F.R.I.C. for very many years research director of Berry Wiggins & Co. Ltd., read a paper entitled "Bitumen and its uses." In the absence of the chairman the meeting was presided over by the vice-chairman, A. W. Deller.

Mr Licence began with a survey of the many attempts to define bitumen which showed, right from the start, the very varied nature of what might appear at first sight a rather hum-drum product. A film entitled *Asphaltic Bitumen* was then shown and gave a general idea of the main properties of bitumen and the research which is behind it, related to some of its principal uses. Following this general introduction, the speaker gave a most interesting description, illustrated in part by lantern slides, of

the developments which have taken place since man's earliest experience of the use of bitumen. From his unrivalled experience Mr Licence produced very many striking examples of problems raised by the ever-widening range of uses for asphaltic bitumen and the difficulties facing the research workers in their attempts to overcome them.

Among a variety of facts about bitumen mentioned by the speaker, which are perhaps not very well known outside the circles closely concerned with the product, might be quoted its use in large scale buildings in the form of bituminous putty and its remarkably high electrical resistance and dielectric breakdown strength, for which some striking comparative figures were given. Among examples of the many secondary advantages peculiar to bitumen under various applications, one recalls the spinning of blown bitumen inside water pipes which produced an internal surface coating of such high polish that the consequent reduction in frictional disturbance to the water flow actually showed significant savings in the pumping power necessary to move a given volume of water.

A discussion followed the paper, and at its conclusion A. W. Jarman, in proposing a vote of thanks, paid a personal tribute to Mr Licence, under whom he had served many years previously. The vote of thanks was carried with enthusiasm and subsequently a number of the members helped to entertain the speaker at a small informal dinner.

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COMPANY PRODUCTION—CRUDE OIL, 1951

	Sept. Tons	Oct. Brl.	Nov.
Kuwait Oil Co :			
Kuwait	2,548,717		
Kern Oil Co :			
California		114,593	
Trinidad		67,257	
British Controlled Oilfields :			
Venezuela			
Western Area ...		12,590	12,092
Central Area ...		15,915	15,201
Trinidad Petroleum Development Co		257,613	249,430

FACTORS AFFECTING REFINERY DESIGN AND OPERATION *

By M. A. L. BANKS† (*Fellow*)

The statement has been published that the oil refining industry in the United Kingdom is to be established, in the first instance, at a figure of 20 million tons per annum. Before the last war such refining as was done in the U.K. totalled some two million tons and today it approaches 8 million tons/year. A change in an industrial pattern which is certain to have far-reaching effects on the lives of a great many people, particularly those engaged in the industry, is therefore being witnessed.

Twenty million tons per annum of oil corresponds, on a B.Th.U. basis, to nearly 30 million tons of coal. From the energy production point of view the refining industry will therefore handle some 15 per cent of the total energy provided by coal. It will be the responsibility of the industry to ensure that the maximum possible proportion of this energy is delivered to the consumer and the minimum lost in the process of refining.

The establishment of an industry at a point of consumption as distinct from the point of production, which was largely the case before the war, means that full freight cost has to be borne on the fuel consumed in running that industry. On twenty million tons, assuming a fuel consumption of 10 per cent, there would be a fuel consumption of two million tons, equivalent to a Sterling value for freight cost of perhaps £6 million or 6/- per ton. This figure is an approximation, bearing in mind the effect of the large tanker and the availability of crude oil on the Eastern Mediterranean seaboard. This is as it were the "handicap" of the industry—the price paid for the employment and technical interest which will result from refining at the point of consumption, namely the U.K.

It is interesting to compare the refining position in another European country—Western Germany with its population of some 50 millions. The amount of refining planned there is of the order of four million tons per annum. This compares with a pre-war figure of perhaps one million tons per annum, but the interesting feature is that conditions in Germany before the war were such as to encourage the establishment of a multitude of small refineries. The fundamental cause was the national determination to encourage the use of indigenous fuel, whether coal or petroleum, by putting very great protection on products produced from indigenous material. As a result there was little incentive for high efficiency in refining, an example of the evils of eliminating competition.

The U.K. refining programme is largely based on refineries of the order of two million tons/year in the first instance. From the refinery plans which have been published it is clear that in general distillation equipment of not less than one million tons/year capacity is regarded as a satisfactory size for the expansions planned.

Capacity is not the only matter on which there appears to be general agreement. Refining, hitherto a progressive and constantly changing industry, appears to have settled down as a result of the urgent developments, notably catalytic cracking, which occurred during the war, and there is therefore a somewhat conventionalized pattern involving

*From a talk given before Stanlow Branch on January 17, 1951.

†Anglo-Iranian Oil Co.

atmospheric distillation, feed preparation plant for catalytic cracking, probably thermal or other type reforming on some of the naphtha, and added treating equipment for motor gasolines and kerosines.

In the U.K. this chain of equipment operating on Middle East crude, will yield products such as are given in Table I.

TABLE I
REFINERY YIELDS

	Per Cent
Motor gasoline 75 octane with 1.5 cc T.E.L.	35
Kerosine and Gas Oil	25
Fuel oil	30
Loss and fuel consumed ...	10
Total	100

A rounded-off refinery would certainly include lubricating oil plant and on a two million-tons basis production of some 40/50,000 tons of lubricating oil could be included in the pattern. The yields already quoted for the base products would then, of course, have to be adjusted correspondingly.

The purpose of the foregoing has been to arrive at some figures for a hypothetical refinery adjusted to suit the U.K. conditions, namely for the processing of two million tons/year of crude with the equipment noted, together with 50,000 tons of lubricating oil of the various grades. This, in general terms, is the tool which is going to put suitable refined products on the British market. It will be the job of the people in the industry, first to design their refineries, and, secondly, to run them for maximum efficiency, and it will be instructive to consider what this work of design and operation is likely to cost and what contributions can be made towards its greater efficiency. Process equipment is largely of U.S.A. design and one cannot help speculating what contributions to improved operation the British refinery employee is going to make.

Very approximately the cost of such a refinery divides into the following proportion if administrative costs, taxes, land charges, and other costs which are in fact common to everything installed are excluded.

TABLE II
REFINERY—CAPITAL COST BREAKDOWN

	Per Cent
Process	35
Utilities, pipelines, tankage and pumping	33
Building, offices, roads, civil work, etc.	32
Total	100

It is important to note that the cost of the process equipment, which represents oil technology in its most complex form, is only one-third of the total cost of the job. Just as much engineering and high-powered design effort should go into the other two major components into which the total capital effort was divided. This factor is not always appreciated. The correct placing of a road or a building needs precisely the same, or even more, engineering scrutiny as does the proper design of a process plant and the same applies to the provision of the utilities.

Once the refinery is designed and erected the depreciation figure is set and has to be added to the cost of operation. Cost of operation divides between materials and labour required, first for pure operation, and secondly for maintenance of the equipment, both of these being regarded as direct costs. To these have to be added indirect costs such as office overheads. Very approximately the percentages of these costs may be set out as in Table III.

The importance of design in determining final cost is obvious, and the same applies to fuel consumption, this latter figure including the consumption for steam, power, and water supplies.

TABLE III

REFINERY COSTS—PERCENTAGE ALLOCATION

	Per Cent
Depreciation	38
Operation	
Fuel Consumption ...	27
Supervision and labour } Materials }	13
Maintenance	
Supervision and labour } Materials }	10
Indirect	12
	100

It is unfortunate that those designs which provide for maximum fuel economy often merely succeed in setting the operator an awkward problem from the point of view of securing maximum continuity of operation.

Most people will agree that little change can be made by operating personnel once the basic design of the refinery has been set. As far as managements are concerned, the elimination of fear of mechanical failure, which has a dominating influence on operational methods, would probably be the greatest contribution that could be made. Complete reliability of machinery and utilities would make a very important difference to refinery methods.

The problem of maintenance immediately arises. Efficient maintenance has three vital facets :—

Craft or workmanship,

Organization, which includes planning,

Inspection, coupled with adequate records.

Just how these three aspects should be linked together for the complete elimination of unexpected breakdowns must vary with individual refineries.

The larger the refinery the more the three functions can be separated, but whether or not they can be separated physically into separate sections or departments, they must be separated mentally by the individual concerned with maintenance. The organization must be such that there is no idle time.

All this may appear a little obvious but from actual experience it is remarkable the reduction in costs which can accrue as a result of clear thinking at all levels in an organization.

The refining industry as a whole has still a very long way to go before it can be said to have streamlined its maintenance side. This means elimination of all failures of utilities ; establishment of corrosion rates ; carrying out of all maintenance on a prevention basis, i.e., before and not after breakdown ; automatic control of all operating variables.

As to indirect costs, it is difficult to criticize these, as they must vary so much as between different localities. It is worth while recording however how alarming is the increase in paper work involved in modern industrial practice. This to some extent is based on the necessity for the individual to be on record or covered, coupled with the thirst of Government Departments, and Head Offices, for written information.

In Table III the indirect cost is equal to the cost of maintaining the whole refinery and though classified as indirect it is nevertheless a very direct charge on the refinery as a whole.

Utilities

In an average refinery cost of utilities is a major factor representing perhaps 25 per cent of the overall cost, including capital. It is remarkable how technical problems can vary from refinery to refinery. Some varied examples of cooling water problems follow.

In one South of France refinery sea water is used and a number of troubles ensue—corrosion of steel, graphitization of cast iron, deterioration of reinforced concrete.

At the north end of the Adriatic the sea water used is contaminated with industrial effluents and sewage and on one particular unit the exchangers are designed with water velocities of around

2 ft/sec which is too low to prevent sediment and slime blocking the tubes. This leads to high temperatures and corrosion.

Fresh water used in Abadan from the Shatt river is subject to seasonal salt incursions giving a maximum total dissolved solids of nearly 4,000 p.p.m. and under normal circumstances the water is brackish—but the slight scaling tendencies of the water tends to inhibit the system against corrosion.

In a U.K. refinery when water from a separator was pumped back to the cooling tower the cavitational tendencies of a particular design of pump were aggravated by the presence of volatile hydrocarbon fractions in the water.

All these difficulties can be overcome by study but the first essential is that no one, particularly a designer, should imagine that water is a simple substance.

The provision of steam and power to a refinery is a subject by itself. There are many combinations varying from 100 per cent use of the grid to 100 per cent separate refinery installation. Probably the optimum from both the capital and operating cost angle is the combination of the back pressure turbo-generating set and the grid—full refinery throughput is dependent on the grid but partial throughput and essential services can be maintained over a grid shut-down.

This system provides maximum fuel economy but whether it gives satisfaction to the refinery man must depend on whether the automatic gear works 100 per cent of the time. A regulator must control the flow of steam to the turbines in accordance with process steam demands, thus ensuring that, in normal parallel operations with the grid, all the cheap power possible is generated consonant with the process steam demand. If the power demand rises relative to the steam demand, then the deficiency of power is made up by the grid. On the other hand, if the power demand drops relative to the steam requirement so that no power is taken from the grid, the grid is automatically disconnected by a reverse power relay. With this latter abnormal condition the control gear becomes inoperative and control of the machine passes to the speed governing gear. In this case, the excess steam requirement is automatically by-passed round the machines and desuperheated by reduction valve equipment.

As already mentioned, from the point of view of the refinery operator continuity of power supply is essential. If it can be absolutely secure, considerable economies in 24-hour supervision costs may be effected.

Over the years, electric power has been increasingly employed. For example, essential pumping duties, e.g., cooling water, which at one time were steam driven, were next electric-driven with a gravity standby, and now some refineries employ electricity alone. Such use, however, depends on the risk involved. Thus, the blowers on catalytic crackers which provide the air for fluidizing the catalyst are steam driven, for a momentary failure would be serious and costly.

Process Considerations

One of the more important problems to be resolved in the new refinery developments will be the handling of gas production, including liquid C_3 and liquid C_4 production. For example, on a two million ton/annum basis the total quantity of some 70,000 tons/annum of C_4 cut will be manufactured, of which approximately 30,000 tons will have come from the crude.

There are a number of destinations for this material. It can be sold as liquid gas, it can be included in motor gasoline as a component having an octane number of 90, it can be polymerized or it can be alkylated.

The motor gasoline produced would absorb the whole of the saturated butane from the crude. Polymerization of the unsaturated butane would give

some 30,000 tons of a gasoline component having an octane number of 80 and a blending value of 120, and some saturated butane left over from the cracked production after polymerization would be available for sale. The alkylation of the unsaturated butane would produce some 45,000 tons of alkylate and there would be no butane for sale as liquid gas; in fact there might be a butane deficiency nn the manufacturing scheme.

The decision whether to incur the very great expenditure of an alkylation plant is of course entirely dependent on the question as to whether 100 octane type fuel will continue to be required for aviation purposes in the years to come. It would appear fairly certain that as far as the civilian requirements are concerned, in view of the high fuel consumption per unit of time which is inherent in turbine engines and the difficulty therefore of handling heavy traffic in and out of aerodromes, that 100 octane material will continue to be required for a long time.

Turning to the C_3 fraction, a small quantity would be recoverable from the crude and a total of perhaps 45,000 tons would be produced from cracking and reforming. Not all of this could be recovered without heavy cost in recovery equipment but assuming 60 per cent recovery as a conservative figure some 25,000 tons of liquid C_3 fraction could be made available. A market for this material as such would be doubtful, but it does seem that should the refineries come to be regarded as a potential source of gas for distribution through National Gas Board channels then liquid propane might well play a part in assisting continuity of supply.

While the view has been expressed that gas from a refinery is a surplus product for which the refineries are anxious to find an outlet it is of course a preferred type of fuel in any refinery and its sale is simply a method of promoting the consumption of liquid fuel oil as a whole. The formation of the National Gas Boards and the possible development of gas grids brings into prominence the gas which will be produced from the refinery programme. Thus a two million ton refinery can produce, say, a total of 40 million cu. ft/day or 120 tons/day of gas, B.Th.U. value 1,100 per cu.ft., having the following approximate composition :—

	Per cent by wt.
C_1	20
C_2	40
C_3	40

If this quantity of gas available from the refinery is of the same order or larger in comparison with the local consumption figures, difficulty can arise over continuity, for it will be subject to violent fluctuations as the producing units are shut down or started. For obvious reasons the supply of gas to domestic and industrial consumers cannot be arbitrarily interrupted. Methods of overcoming the continuity difficulty must depend on the amount of gas that is involved. In small consuming areas liquid C_3 storage might well solve the problem and thus promote an additional outlet. The use of standby gas producer plant in the National Gas Board installations is another system, and an alternative, somewhat far-fetched perhaps but worthy of consideration, is the use of standby cracking equipment of the low pressure type for cracking heavy oil mainly for gas and producing cracked spirit as a by-product while the more important cracking equipment is shut down for overhaul.

No comments on gas production are complete without reference to the question of desulphurization of gas. This can be in order to reduce the nuisance of SO_2 evolution, as a means of recovering sulphur, as a method of making the gas suitable for domestic use, or for a combination of these purposes. Assuming a normal desulphurization method, a two-million ton

refinery would produce some 2,500 tons/year of sulphur, or enough to cover fully the sulphuric acid requirements of that refinery. Although by no means a major contribution to the sulphur deficiency position as a whole, it would have some value.

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U.S. PETROLEUM REFINERIES

Although on January 1, 1951, the number of petroleum refineries in the United States was 10 below that a year before, the throughput capacity had increased by 267,344 b.d. during the year. This follows the general trend of recent years for throughput to increase while the number of plants decreases. Operating ratio at the beginning of 1951 was 92.6 per cent compared with 81.9 per cent at the same time in 1950. Details from U.S.B.M. Information Circular 7612 are:

	January 1	
PLANTS	1951	1950
Operating:		
Number	325	320
Crude capacity, b.d.	6,701,815	6,222,998
Shut down:		
Number	32	47
Crude capacity, b.d.	261,829	473,302
Total:		
Number	357	367
Crude capacity, b.d.	6,963,644	6,696,300
Building:		
Number	1	2
Crude capacity, b.d.	160,100	145,600
Cracking Capacity:*		
Operating	1,808,746	1,732,241
Shut down	44,360	88,442
Building	161,155	94,045
Types of plant:		
Reforming	295,500	307,007
Thermal	776,796†	784,621†
Catalytic	780,810	729,055

*In terms of cracked gasoline production.

†Includes some reformed and catalytic.

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Portable Oil Heater. At a Beaumont, Texas, refinery recently a worn-out visbreaker was replaced with a 900-ton modern heater with a down-time of only six weeks. Step-by-step photographs and descriptive matter are included in a 16-page brochure obtainable from The Lummus Co., 385 Madison Avenue, New York, 17, N.Y., U.S.A.

ABU DHABI ARBITRATION AWARD

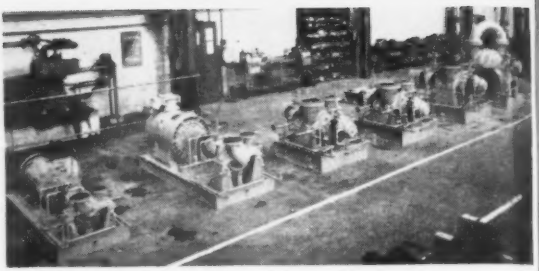
An Arbitration which took place in Paris last August, has now been completed by the announcement of the Award by the Umpire, The Right Hon. Lord Asquith of Bishopstone.

The Arbitration was between His Excellency Shaikh Shakhbut bin Sultan bin Za'id, Ruler of Abu Dhabi, a Principality on the Arabian side of the Persian Gulf, and Petroleum Development (Trucial Coast) Limited, an associated company of the Iraq Petroleum Company, Limited.

The dispute arose from the grant during 1950 of a Concession by the Shaikh to The Superior Oil Company, a Californian Corporation, giving that company oil rights over the sea-bed and subsoil of a marine area off the coasts of Abu Dhabi. By Proclamation issued on 10 June, 1949, the Shaikh declared this submarine area to appertain to Abu Dhabi and to be under its jurisdiction and control. Similar proclamations have been made by many States in recent years and such submarine areas are frequently referred to as the "Continental Shelf."

The right of the Shaikh to dispose of the oil rights over this submarine area was disputed by Petroleum Development (Trucial Coast) Limited, which contended that they were already included in the Concession which it had obtained from the Shaikh in 1939. The Shaikh also contested the claim of the Company that its Concession included the oil rights in the sea-bed lying under the territorial waters of Abu Dhabi.

Lord Asquith awards that the Concession to Petroleum Development (Trucial Coast) Ltd. includes the subsoil of the territorial waters (including the territorial waters of the islands) but not the subsoil of the Shelf; the latter being defined as the submarine area contiguous with Abu Dhabi outside the territorial zone.



Some of the process pumps manufactured by Sigmund Pumps Ltd for the Shell Company's second distillation unit at Cardon, Venezuela. When completed, this refinery will have a total intake of 140,000 barrels a day.

The six types of pumps shown are designed to handle (a) 1650 U.S. gal/min of crude oil at 160° F; (b) 2060 U.S. gal/min of topped crude at 600° F; (c) 1450 U.S. gal/min of gas oil at 300° F; (d) 240 U.S. gal/min of gas oil at 480° F; (e) 150 U.S. gal/min of naphtha at 408° F and (f) 50 U.S. gal/min of propane at 110° F.

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GRAIN DRYING

For those concerned with the storage and handling of grain, the Shell-Mex and B.P. Farm Service has produced a film which combines the maximum of enlightenment with considerable entertainment value. Running for nearly an hour, "Grain Drying" is in two parts, the first sequence outlining the basic problems involved in producing suitable grain for the farmer's main customers, the maltster and the miller. The second treats the subject of drying from the farmer's point of view. In both parts, the information is conveyed against beautifully photographed backgrounds of machinery and countryside, and the commentaries by miller, maltster and farmer—particularly the last-named—are delivered with persuasive charm.

The vital part played by mechanization of farming in the development of home food production was emphasized by Mr C. M. Vignoles, managing director of Shell-Mex and B.P. in a talk preceding the first showing of the film. He said the tractor population had grown from 55,000 in 1938 to 385,000 at the beginning of 1951. With these developments went a great increase in the demand for petroleum products. Whereas in 1938 only 4 per cent or 100 million gallons of petroleum products were used in agriculture, today 9 per cent or 350 million gallons of petroleum products were so used.

Copies of the film, which is available in black and white in both 16 mm and 35 mm, can be obtained from the Trade Relations Dept. at Shell-Mex House, London, W.C.2., or any Divisional Office of Shell-Mex and B.P. Ltd.

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ASTM STANDARDS

The 1951 volume of ASTM standards on petroleum products is now available from the offices of the Institute, price being 42s post free. This volume contains the latest information on American methods for testing petroleum and its products.

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BIRMINGHAM STUDENTS BRANCH

All members and friends are invited to take part in a social evening at the Annual Dance of the University of Birmingham Chemical Engineering Society and Student Section of the Institute of Petroleum, which will be held at the Guild of Undergraduates Union, University Road, Edgbaston, Birmingham, 15, on Friday, February 8, 1952.

Continued at foot of opposite page

FORTHCOMING MEETINGS

THE INSTITUTE

The Lubrication of Gears and the Testing of Gear Lubricants. A Symposium of papers arranged by C. G. Williams, D.Sc. (*Thornton Research Centre, "Shell" Refining & Marketing Co.*) At 26 Portland Place, London, W.1, 2.30 p.m. (*tea 5 p.m.*) February 13.

Air and Vapour Release from Aviation Fuels. L. D. Derry, E. B. Evans, Ph.D., M.Sc., B. A. Faulkner, B.Sc., and E. C. G. Jelfs, B.Sc. (*Esso Development Co. Ltd.*). At 26 Portland Place, London, W.1, 5.30 p.m. (*tea 5 p.m.*), February 25.

Alcohol Motor Fuels. 1. Economics. T. C. Owtram, M.B.E., M.C., M.A., (*Shell Petroleum Co.*). **2. Manufacture and Use.** S. J. W. Pleeth, B.Sc., (*Cleveland Petroleum Co.*). At 26 Portland Place, London, W.1., 5.30 p.m. (*tea 5 p.m.*), March 12.

Comparison of "Slurry," Fluidized Bed, and Fixed Bed Operation in the Fischer-Tropsch Process. C. C. Hall, M.Sc. Ph.D. (*Fuel Research Station, D.S.I.R.*) At 26 Portland Place, London, W.1., 5.30 p.m., (*tea 5 p.m.*), March 26.

Fawley Branch

Instrumentation in The Petroleum Industry. At Esso Recreation Club, Holbury, 7.30 p.m., February 13.

Distribution of Petroleum. C. H. Collins. At Esso Recreation Club, Holbury, 7.30 p.m., March 19.

London Branch

People and Oil. A. C. Palmer. At 26 Portland Place, London, W.1, 6 p.m. (*tea 5.30 p.m.*), January 22.

Address by the President. At 26 Portland Place, London, W.1., 6 p.m. (*tea 5.30 p.m.*) February 20.

Northern Branch

Developments in Laboratory Methods and Technique. Dr. J. B. Matthews. At Engineers' Club, Albert Square, Manchester 2, 6.30 p.m., February 19.

The Fawley Refinery. G. Noble, J.P., B.Sc., At Engineers' Club, Albert Square Manchester, 6.30 p.m., March 18.

Scottish Branch

Paper by R. H. Sheldrake. At Glasgow February 7.

Film Show. At Edinburgh, March 6

Stanlow Branch

Thermal Factors in Furnace Design. Prof R. J. Sarjant, O.B.E., D.Sc., and C. Hulse, B.Sc. Joint meeting with Institute of Fuel. At Grosvenor Hotel, Chester, 7.30 p.m., February 20.

Function of a Refining Control Laboratory. D. H. Japes, M.Sc., At Grosvenor Hotel, Chester, 7.30 p.m., March 19.

OTHER SOCIETIES

Fuels for use in Marine Auxiliary Oil Engines. C. D. Brewer. Institution of Marine Engineers. At 85 The Minories, London, E.C.3, 5.30 p.m., February 12.

Discussion on British Standards for Bituminous Materials used in the Road and Building Industries. Society of Chemical Industry. At 11 Upper Belgrave Street, London, S.W.1., 6 p.m., February 12.

Petrol Engine Knock. A Symposium. Institution of Mechanical Engineers, Storey's Gate, London, S.W.1., 5 p.m., February 22.

A reception room is being reserved for members of the Institute of Petroleum, Institution of Chemical Engineers, and the Institute of Fuel. Paul Kingsley and his Orchestra will play from 8.0 p.m. to 1.0 a.m. and there will be a bar until 12.0 p.m; dress will be informal.

Tickets and further information can be obtained from the Student Section secretary—P. F. Jones, c/o Department of Chemical Engineering, The University, Birmingham, 15. Tickets 11/6 double and 6/6 single (supper included).

Members of the Institute of Petroleum who live within convenient distance of Birmingham and are either not mentioned in the July 1950 List of Members or have moved into the vicinity since, may be interested in certain activities of the Student Section in Birmingham. If they will communicate with the Student Section Secretary—P. F. Jones—he will be pleased to keep them informed of the dates and nature of such activities.

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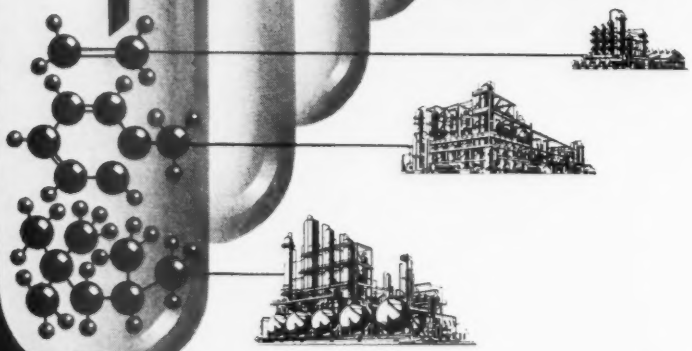

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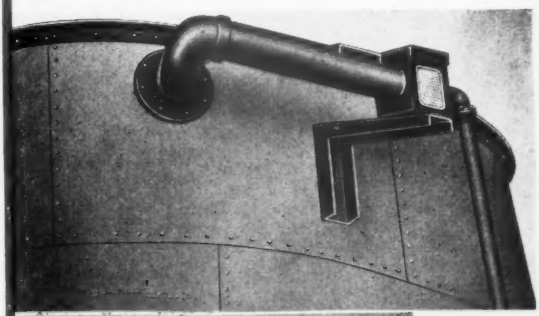

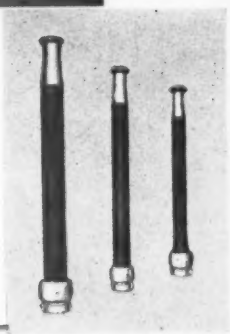

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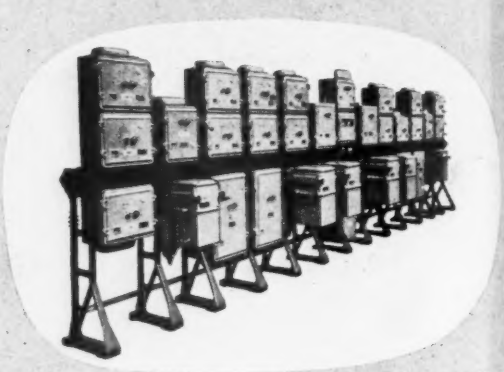

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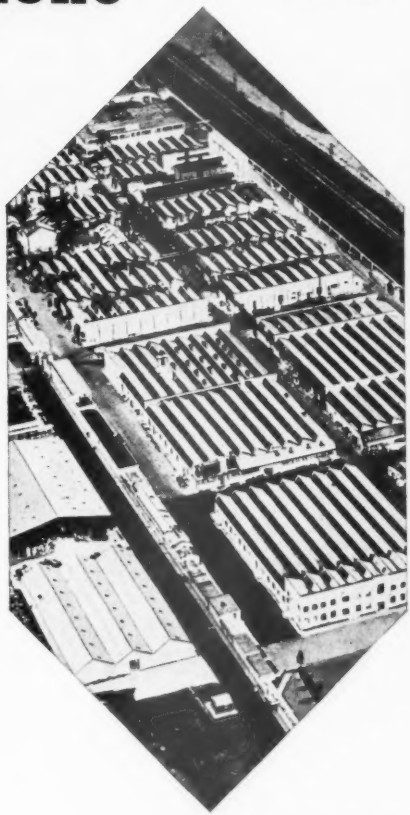

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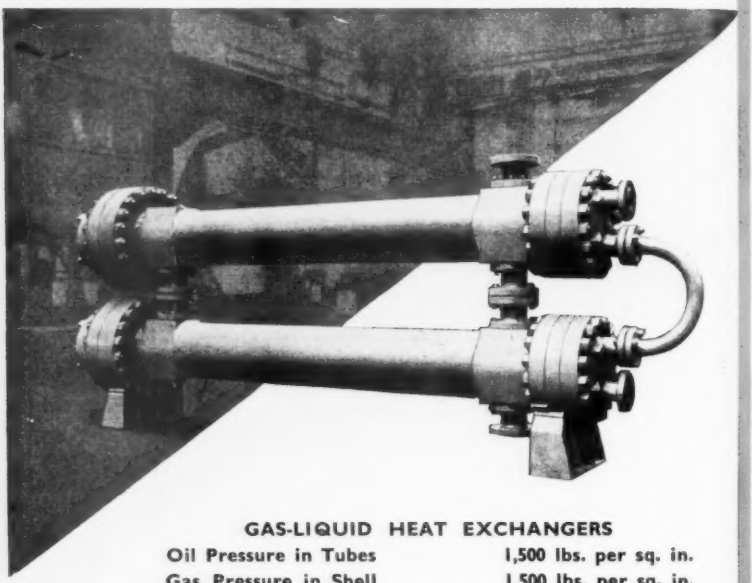

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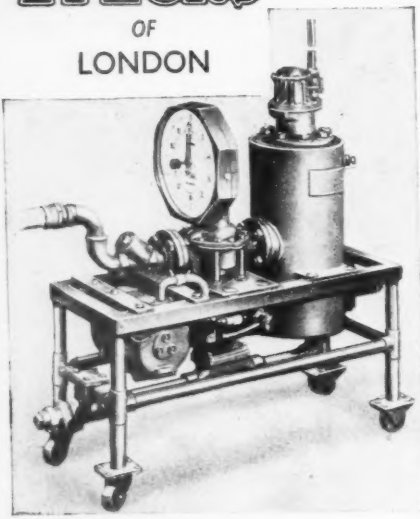

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